



Sunrun Grid Services

Sunrun foresees long term, robust growth in distributed, customer-sited solar for the coming decade, across multiple regions of the country. Solar costs will decline and retail rates are expected to rise, uncoupled from declining wholesale prices due to increasing transmission and distribution costs.¹ Residential solar has the potential to address up to 40% of total U.S. electricity load consumed by residential users, driven by organic customer demand for clean energy, savings and energy choices.² As these resources grow, the best path for customers and the grid is to maximize opportunities for smart integration. Our job is to figure out how to put this private investment to work in a way that saves all ratepayers money from deferred public investment in additional, redundant infrastructure.

Home Solar + Battery Storage

Sunrun deploys home battery storage paired with solar, a smart inverter, and certain load management capabilities. Sunrun typically utilizes a DC-coupled architecture for 100% solar charging of the battery, with connectivity via WiFi or cellular for remote asset monitoring and dispatch. In the event of an outage, the system safely islands from the grid and powers the home. In an extended outage, solar panels in island mode are capable of powering the home and charging the battery for backup, providing a new form of site-level resiliency not previously available to ordinary homeowners.

The Sunrun system also optimizes battery storage and solar production for customers based on rate design, depending on the market. Sunrun customers are rapidly adopting battery storage paired with solar because they benefit from savings on their monthly electric utility bill. Over the last 12 months in California, nearly 20% of the time our solar customers are now choosing to add batteries. This has almost doubled again this quarter. Sunrun expects home battery storage adoption to continue to increase.

Aggregation for Grid Services

Sunrun's fleet management capabilities across 180,000+ distributed assets, both solar and solar+storage, enable aggregation of individual sites for optimized dispatch for both customer and grid value. Sunrun participates in utility and ISO Demand Response programs, including the PG&E Demand Response Auction Mechanism and the CAISO Proxy Demand Resource.

Home solar+battery storage can provide system and local benefits and be aggregated to provide wholesale products and distribution level value:

- Generation capacity
- Transmission capacity offset / deferral
- Distribution capacity offset / deferral
- Operating reserves
- Frequency regulation and response
- Voltage support

Maximizing System Benefit

Sunrun Grid Services reflects the unique role that distribution-interconnected, behind-the-meter resources can play:




¹ See, e.g., <https://www.eia.gov/todayinenergy/detail.php?id=32812>.

² See, e.g., <http://enduse.lbl.gov/Info/LBNL-47992.pdf>.

- Integrating value streams provided by solar, storage and load management into straightforward and compelling customer value propositions, in order to make it simple for ordinary Americans to understand the value of these technologies and adopt them when they adopt home solar.
- Using the unique locational value of customer-sited battery storage to provide value at specific sites, while simultaneously adding coincident system value, and/or managing DER aggregations so as to optimize value across both.
- Leveraging the capabilities of distributed generation and storage that are uniquely sited in proximity to demand but need not be defined within the limitations of traditional demand resources. Generation and storage are fundamentally more flexible, firm and durable than traditional demand resources. An approach that limits the contributions of behind-the-meter assets to the parameters of traditional demand resources purely because of where they are sited turns their greatest value, the ability to provide locational value, into a liability.
- Recognizing that for distributed resources to reach their full potential for system benefit, host customers must readily adopt them. The processes to interconnect small, modular assets must be predictable, affordable and straightforward for customers.

Choose Grid Integration, not Defection

A risk for the grid is that residential batteries are adopted but not fully valued by the distribution and energy markets, leading to inefficient investment and potentially grid defection. For example, 3+ million American homes currently have standby generators, suggesting that the market potential for residential batteries for backup value alone is substantial; batteries are cleaner, quieter, provide substantial backup power when paired with solar, and are on a path to becoming less expensive than whole home generators.

Virtual Distribution Capacity	Virtual Transmission Capacity	Virtual Power Plants
 <p>Avoids substation overhauls by dropping excess load when needed locally.</p> <p><u>Solution:</u></p> <ul style="list-style-type: none"> • 600 solar + storage homes on a residential circuit with 6,000 homes • 4.5 MWh / 3 MW storage manage circuit load to safe limits 	 <p>Provides generation and reliability in congested areas where new transmission lines are difficult to build.</p> <p><u>Solution:</u></p> <ul style="list-style-type: none"> • 10,000 solar + storage homes in load zone with 200k homes • Daily peak shaving + reliability in loss of transmission capacity 	 <p>Provides clean, cost effective peaking capacity.</p> <p><u>Solution:</u></p> <ul style="list-style-type: none"> • 50,000 solar + storage homes in utility territory with 1M residential customers • 92MW, 4-hour duration resource

If just one million American homes adopt 10 kWh home batteries but there are no means to utilize this capacity for grid value, 10 GWh of battery capacity and an estimated \$5 billion in modern energy infrastructure will sit unutilized for the 99% of the time that backup power is not needed. A better path is integrating these customer-provided resource into the grid by fully valuing and compensating the capabilities of the energy assets.